AD-A101 836 MISSOURI UNIV-ROLLA GRADUATE CENTER FOR CLOUD PHYSICS--ETC F/G 14/2
CONSTRUCTION OF FULL SIZE CLOUD SIMULATION CHAMBER.(U)
JUN 81 D R WHITE F49620-80-C-0090
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PROGRESS REPORT

(TWENTY COPIES REQUIRED)

1. ARO PROPOSAL NUMBER: N/A

2. PERIOD COVERED BY REPORT: January 1, 1981 - June 30, 1981

3. TITLE OF PROPOSAL: Construction of Full Size Cloud Simulation Chamber

4. CONTRACT OR GRANT NUMBER: F49620-80-C-0090

5. NAME OF INSTITUTION: University of Missouri-Rolla
Graduate Center for Cloud Physics Research

6. AUTHOR(S) OF REPORT: Daniel R. White

7. LIST OF MANUSCRIPTS SUBMITTED OR PUBLISHED UNDER ARO SPONSORSHIP DURING THIS PERIOD, INCLUDING JOURNAL REFERENCES:

8. SCIENTIFIC PERSONNEL SUPPORTED BY THIS PROJECT AND DEGREES AWARDED DURING THIS REPORTING PERIOD:

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BRIEF OUTLINE OF RESEARCH FINDINGS

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
cloud chamber, cloud simulation, expansion chamber

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Work on construction of the full size cooled wall cloud simulation chamber has been pursued in three main areas. The mechanical construction has begun the assembly of the small Proto II chamber and started machining of the major components of the large Romulus chamber. The study of the temperature uniformity over the surface of the inner wall plates was completed. The design problem with the primary chamber sealing gaskets was solved. The

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

optical table and tower for the Romulus chamber were purchased and set up for testing. Also a preliminary design for an actively cooled window port was developed. Construction of the switching power supplies, and development of the control systems for the thermoelectric modules used for wall temperature control was initiated. Drift problems with the transistor thermometers were traced to changes in manufacturers' procedures and corrective measures were taken to solve the problem.

Statement of Work

The purpose of this work is to construct a 10 foot tall cooled wall cloud simulation chamber capable of cooling at 15°C/min. Construction will include secondary cooling, computer control and data acquisition, and other control systems required for operation of the chamber. The chamber will be incorporated into the existing UMR prototype facility.

Introduction

During the past year work in many areas has proceeded from the planning and design stages to construction, testing and assembly. While significant work has been accomplished in both the electronics and optical area the most visible results have been in the mechanical work.

The post mortem of the Proto I chamber completed at the end of the first year's work verified that the invasion of the thermoelectric modules by the potting compound used for sealing had caused mechanical separation of the modules due to thermal expansion during high power operation. This meant that the problem of gasket seals had to be solved for both the Proto II and Romulus chambers. The additional engineering studies required have caused a shift in the areas of concentrated effort.

Mechanical Work

An extensive study of the temperature uniformity over the surface of the chamber inner wall plates has been carried out. Several small but important modifications have resulted. First it was found that without the massive reverse heat flow due to the potting compound the uniformity of temperature was very

sensitive to the flatness and uniformity of thickness of the thermoelectric modules placed under each inner wall plate. This resulted in a revision of the specifications on the thermoelectric modules prior to purchase. With the Proto II chamber it was found that the edges of the inner wall plates had to be beveled to reduce the mass of plate material per thermoelectric module to more nearly match that of the modules in the center of the plate.

Since the sealing gasket around the edge of the inner wall plate represents a major possible heat leak between the heat sink and inner wall plate a program to design a suitable gasket was carried out with the temperature studies. The resulting gasket utilizes a molding compound which forms a closed cell foam during the curing process. Both studies have been carried out for the Proto II chamber, however the results apply directly to the Romulus chamber.

Many of the small parts such as those for the manifolds connecting the secondary cooling system to the heat sinks are being cast using a filled epoxy compound. The parts for Proto II are nearly complete and the required molds for Romulus parts are ready. Fabrication of the remaining parts is proceeding at the rate of a few per day until the required number is complete.

Machine work on the top and bottom heat sinks and one section of side wall heat sinks for Proto II is complete and work on the second set of side wall heat sinks is underway. The top and bottom heat sinks have been anodized and the cooling manifold assembled and successfully tested. Work on the heat sinks

for the Romulus chamber has been started but is currently behind schedule, however, the university central shop is making a major effort to make up for lost time. They have received the numerical controls for their vertical milling machine and now have all the items of major equipment required to complete the work.

Based on the results of the temperature uniformity tests the thermoelectric modules required were purchased. Due to the close tolerance required for thermoelectrics under a single plate, ±0.0001 in., and the number of thermoelectric modules involved, 7000 modules, a computerized gaging system was developed to measure the flatness and thickness of each module. The system was used to determine acceptance of the modules from the manufacturer. The resulting data base is also being used to select the modules which are suitable for use under a single inner wall plate. Selection and internal wiring of the sets for Proto II is approximately 50% complete.

Other areas of work have included completion of the assembly hoist for Proto II and acquisition of parts for the Romulus hoist. The concrete pad which will provide a base for both the Romulus chamber and optical table was completed. The system for cleaning, drying and saturating the air used in sample preparation was overhauled and relocated to accommodate the two new chambers.

Keeping in mind the extensive tests required for the inner wall of Proto II, a test section duplicating one face of a Romulus side wall heat sink has been completed along with pieces to serve as the two adjacent faces. This test section will be used to verify the temperature uniformity of the inner wall plate, gasket

design and manifold designs.

A computer model of the heat transfer in the Romulus chamber has been developed using an electrical analog technique. This model now includes the external secondary cooling loop and will be used to develop the required specifications for the secondary cooling system.

Optical Work

It was our original intention to construct the optical table and framework for Romulus ourselves, however, the saturation of our work force and the need to insure internal damping of the system resulted in a decision to purchase the table and tower as a unit from Newport Research Corporation. The system has been received and set up for testing. At present the results indicate that the stability of the system is extremely good with little or no long term drift.

In addition to re-evaluation of the Doppler laser scattering system we are designing the optics and mounts required to use the otpical systems on any three of six levels simultaneously. This design is emphasizing self-compensating aspects of alignment and ease of change between levels.

Work with Proto I and preliminary tests with the Proto II test section have shown that the temperature of the windows must be actively controlled. Initial tests of a window consisting of two thin (0.02 in.) sapphire disks with thermostated ethanol flowing between them show that it can be cooled and heated at the rates planned for both the Romulus and Proto II chambers.

Electrical Work

Endurance tests of the power supplies to drive the thermoelectric modules were successfully completed. The power supplies are being built in pairs which are mounted on a set of water cooled heat sinks and an accompaning printed circuit board. Forty percent of the heat sinks for the 240 power supplies have been mechanically assembled. The printed circuit board is in the final stages of layout prior to being sent to a manufacturer. The cabinets and closed loop coolant system have been assembled and are ready for wiring.

The nine 37.5 kVA transformers which will supply the raw power for the thermoelectric power supplies have been received and mounted in an enclosed cabinet together with the associated rectifiers.

The analog control circuit for use on the Proto II chamber is still in the development stage. Several initial designs have been breadboarded and tested on one section of the chamber set up for this purpose, however each has proved unsatisfactory due to excessive offset or instability. Recent results have indicated that additional response tests are required.

The digital control for the Romulus chamber has been computer modeled to determine the control algorithm, and type and quantity of computer hardware required. The modeling has been completed and specifications for the hardware is being developed.

The design of the transistor thermometers used for temperature measurement throughout the system ran into an unforeseen problem when it was discovered that the new sensors did not have

the long term stability of the older ones. Consequently a time consuming and rather sophisticated program was required to determine the cause. It was found that the manufacturer had changed the chip geometry, method of passivating the junction and packaging. The net result was an increase in the susceptibility of the junction to the inbound migration of impurities resulting in an unacceptable amount of long term drift when the transistor is used as a temperature sensor. Once the problem was determined, a search was made for alternative transistors which would be suitable, the final result was the purchase of special chips from one manufacturer and special packaging performed by a second firm. Construction of the new thermometers will proceed as soon as the new sensors are received.

Third Year Work

The machining of the major components of the Romulus chamber will be continued during the early part of the third year. Assembly and testing of the Proto II chamber will be pushed during this period. Design and development of the secondary cooling system for the Romulus chamber will utilize the computer model which has been developed for this purpose.

The development and testing of the optical hardware will continue. Development of the cooled window design will be pushed to permit early incorporation into the machine work. The multi-beam laser system will also be developed and tested.

Development of the control systems for both chambers will be pursued together with the continued work on construction of the switching power supplies. Construction and installation of the new transistor thermometers will also be in progress.

SUMMARY OF EXPENDITURES*
AFOSR F49620-80-C-0090
6/01/79 - 5/31/81

CATEGORY	ROMULUS	PROTO II	SUBTOTAL	TOTAL
E. ELECTRICAL	100,648.19	3,297.32		103,945.51
1. Power	23,328.30	0.00	23,328.30	
a. Entrance	23,328.30	0.00	23,328.30	
b. Distribution	0.00	0.00	0.00	
2. D.C. Power to Thermoelectric Modules	53,472.10	2,345.02	55,817.12	
a. Raw D.C.	16,751.31	0.00	16,751.31	
b. Switching p.s. development & testing	367.85	16.30	384.15	
c. Switching p.s. construction	36,144.79	0.00	36,144.79	
d. Power supply/computer interface	0.00	0.00	0.00	
e. Control network	208.15	1,648.72	1,856.87	
f. Power supply/chamber distribution	0.00	680.00	680.00	
3. Thermometry	10,570.94	941.98	11,512.92	
a. Sensor development & testing	613.95	0.00	613.95	
b. Sensor acquisition & fabrication	3,648.95	320.51	3,969.46	
c. Sensor calibration	3,330.03	36.85	3,366.88	
d. Thermometer elec. circuit construction	508.81	584.62	1,093.43	
e. Temperature data acquisition system	2,469.20	0.00	2,469.20	
4. Stock - Electrical	3,838.80	10.32	3,848.82	
a. Material	1,386.93	0.00	1,386.93	
b. Parts	2,404.10	10.32	2,414.42	
c. Tools	47.47	0.00	47.47	
5. Diagnostic and Maintenance Equipment	9,438.35	0.00	9,438.35	

CATEGORY	ROMULUS	PROTO II	SUBTOTAL	TOTAL
C. COMPUTER	425.48	24.72		450.20
1. Control and Data Acquisition System	112.85	24.72	137.57	
a. Control computer and equipment	0.00	24.72	24.72	
b. Control interface; bus	112.85	0.00	112.85	
c. Software development	0.00	0.00	0.00	
2. Analysis	312.63	0.00	312.63	
a. Computer & peripheral equipment	224.43	0.00	224.43	
b. Interfacing	0.00	0.00	0.00	
c. Software development	88.20	0.00	88.20	
O. OPTICAL SYSTEMS	48,056.54	159.98		48,216.52
1. Optical Table and Tower	43,681.22	75.48	43,756.70	
a. Design	0.00	0.00	0.00	
b. Equipment acquisition	43,443.01	0.00	43,443.01	
c. Fabrication of accessories	248.21	69.80	318.01	
d. Assembly	0.00	5.68	5.68	
2. Doppler and Mie Scattering Systems	299.35	76.83	376.18	
a. Design	18.64	0.00	18.64	
b. Equipment acquisition	0.00	41.35	41.35	
c. Fabrication of accessories	0.00	9.40	9.40	
d. Assembly	0.00	0.00	0.00	
e. Testing	280.71	26.08	306.79	

CATEGORY	ROMULUS	PROTO II	SUBTOTAL	TOTAL
3. Photographic System	4,075.97	7.67	4,083.64	
a. Design	0.00	0.00	0.00	
b. Equipment acquisition	4,075.97	7.67	4,083.64	
c. Fabrication of accessories	0.00	0.00	0.00	
d. Assembly	0.00	0.00	0.00	
e. Testing	0.00	0.00	0.00	
4. Transmission System	0.00	0.00	0.00	
a. Design	0.00	0.00	0.00	
b. Equipment acquisition	0.00	0.00	0.00	
c. Fabrication of accessories	0.00	0.00	0.00	
d. Assembly	0.00	0.00	0.00	
e. Testing	0.00	0.00	0.00	
M. MECHANICAL	73,162.91	25,853.24		99,016.15
1. Top and Bottom Heat Sinks	401.76	3,759.48	4,161.24	
a. Surfacing and sides	0.00	1,257.00	1,257.00	
b. Deep hole drilling	0.00	1,050.44	1,050.44	
c. Short hole drilling & tapping	338.40	1,308.24	1,646.64	
d. Lapping surfaces	0.00	143.80	143.80	
e. Metal acquisition	59.36	0.00	59.36	
f. Design and drawings	4.00	0.00	4.00	

CATEGORY	ROMULUS	PROTO II	SUBTOTAL	TOTAL
2. Side Wall Heat Sinks	1,231.22	8,471.45	9,702.67	
a. Outside flats	0.00	5,999.29	5,999.29	
b. Inside flats	0.00	0.00	0.00	
c. Size length of cylinder	0.00	0.00	0.00	
d. Gun drill deep holes	20.65	0.00	20.65	
e. Fabrication of fixtures	780.33	0.00	780.33	
f. Short hole drilling	186.61	108.00	294.61	
g. Complete end machining	0.00	0.00	0.00	
h. Metal acquisition	231.63	2,362.91	2,594.54	
i. Design and drawings	12.00	1.25	13.25	
3. Inner Wall Plates	3,547.08	2,489.18	6,036.26	
a. Surfacing	1,178.00	0.00	1,178.00	
b. Drilling	0.00	1,470.00	1,470.00	
c. Gluing	131.02	2.65	133.67	
d. Metal and supplies acquisition	2,219.82	332.89	2,552.71	
e. Testing	18.24	683.64	701.88	
4. Hoist	1,406.53	1,757.10	3,163.63	
5. Gaskets	176.99	300.13	477.12	
a. Molding	2.40	0.00	2.40	
b. Fixtures	0.00	39.00	39.00	
c. Supplies & equipment	174.59	261.13	435.72	
6. Cooling Manifolds	881.16	728.26	1,609.42	
a. Molding	203.58	35.38	238.96	
b. Fixtures and forms	11.95	294.00	305.95	
c. Assembly & mounting on chamber	34.61	87.00	121.61	
d. Supply and equipment	615.02	311.88	926.90	
e. Design and testing	16.00	0.00	16.00	

CATEGORY	ROMULUS	PROTO II	SUBTOTAL	TOTAL
7. Base Stand for Chamber	13.86	55.80	69.66	
a. Fabrication	11.86	38.00	49.86	
b. Supplies & equipment	2.00	17.80	19.80	
8. Observation Windows	576.65	0.00	576.65	
a. Development and testing	237.39	0.00	237.39	
b. Machining	0.00	0.00	0.00	
c. Assembly	0.00	0.00	0.00	
d. Equipment or component acquisition	339.26	0.00	339.26	
9. Thermoelectric Control Panel Assembly	3,330.82	1,638.22	4,969.04	
a. T.E. sizing	1,473.66	0.00	1,473.66	
b. Soldering T.E. strings	136.81	0.00	136.81	
c. Assembly	0.00	6.15	6.15	
d. Supply & equipment acquisition	1,720.35	1,632.07	3,352.42	
10. Thermoelectric Control Panel Testing	0.00	0.00	0.00	
11. Secondary Cooling System	0.00	11.92	11.92	
a. Design	0.00	0.00	0.00	
b. Construction	0.00	0.00	0.00	
c. Testing	0.00	0.00	0.00	
d. Supply and equipment acquisition	0.00	11.92	11.92	
12. Aerosol Inlet System	18.80	11.11	29.91	
a. Design	0.00	0.00	0.00	
b. Construction	0.00	0.00	0.00	
c. Testing	0.00	0.00	0.00	
d. Supplies & equipment	18.80	11.11	29.91	

CATEGORY	ROMULUS	PROTO II	SUBTOTAL	TOTAL
13. Expansion Manifolds	35.40	0.00	35.40	
a. Molding	0.00	0.00	0.00	
b. Fixtures and forms	0.00	0.00	0.00	
c. Assembly & mounting on chamber	0.00	0.00	0.00	
d. Supply & equipment acquisition	35.40	0.00	35.40	
14. Overall Expansion System	0.00	0.00	0.00	
a. Design	0.00	0.00	0.00	
b. Fabrication	0.00	0.00	0.00	
c. Assembly	0.00	0.00	0.00	
d. Testing	0.00	0.00	0.00	
e. Supply & equipment acquisition	0.00	0.00	0.00	
15. Assembly of Chamber Subsections	0.00	316.71	316.71	
16. Pressure Transducer	0.00	61.34	61.34	
17. Storage Dollies	85.70	251.98	337.68	
a. Fabrication	0.00	200.00	200.00	
b. Supplies & equipment	85.70	51.98	137.68	
18. Thermoelectric Module Acquisition	52,254.57	6,284.59	58,539.16	
19. Building Modifications	2,645.87	0.00	2,645.87	
a. Planning & design	0.00	0.00	0.00	
b. Materials & supplies	45.94	0.00	45.94	
c. Labor or subcontracts	2,599.93	0.00	2,599.93	
20. Sample & Air Lines	259.29	0.00	259.29	
a. Fittings and valves	161.90	0.00	161.90	
b. Materials & supplies	97.39	0.00	97.39	
c. Assembly	0.00	0.00	0.00	

CATEGORY	ROMULUS	PROTO II	SUBTOTAL	TOTAL
21. Stock items	6,032.16	16.10	6,048.26	
a. Materials	4,970.21	16.10	4,986.31	
b. Parts	299.13	0.00	299.13	
c. Tools	762.82	0.00	762.82	
22. Clean Room	267.94	0.00	267.94	
a. Parts	267.94	0.00	267.94	
b. Construction	0.00	0.00	0.00	
23. Humidifier	174.10	0.00	174.10	
a. Parts	174.10	0.00	174.10	
b. Assembly	0.00	0.00	0.00	
ADMINISTRATIVE	1,078.53	0.00	1,078.53	1,078.53
BLUEPRINTS	56.25	0.00	56.25	56.25
GRAND TOTALS	223,427.90	29,335.26		252,763.16
			Unclassified Machine Shop	+20,479.00
				273,242.16

*Exclusive of salaries, wages, fringe benefits, and indirect costs.

REPORT OF INVENTIONS AND SUBCONTRACTS

(Pursuant to "Patent Rights" Contract Clause)

Form Approved
Budget Bureau No. 22-R160

INSTRUCTIONS TO CONTRACTOR

This form may be used for INTERIM and FINAL reports, and when used shall be completed and forwarded to the Contracting Officer in triplicate.

An INTERIM report shall be submitted at least every twelve months, commencing with the date of the contract, and should include only those inventions and subcontracts for which complete information has not previously been reported.

A FINAL report shall be submitted as soon as practicable after the work under the contract is complete and shall include (a) a summary of all inventions required by the contract to be reported, including all inventions previously reported and any inventions since the last INTERIM report; and (b) any required information for subcontracts which has not previously been reported.

1. NAME AND ADDRESS OF CONTRACTOR *(Include ZIP Code)*

University of Missouri-Rolla
Graduate Center for Cloud Physics Research
Rolla, MO 65401

2. CONTRACT NUMBER
AFOSR F49620-80-C-0090

3. TYPE OF REPORT *(check one)*
[X] a. INTERIM [ ] b. FINAL

SECTION I - INVENTIONS *("Subject Inventions" required to be reported by the "Patent Rights" clause)*

4. INVENTION DATA *(check one)*

[X] a. THERE WERE NO INVENTIONS WHICH REASONABLY APPEAR TO BE PATENTABLE

[ ] b. LISTED BELOW ARE INVENTIONS WHICH REASONABLY APPEAR TO BE PATENTABLE. ANY INVENTION DISCLOSURES WHICH HAVE NOT BEEN PREVIOUSLY SUBMITTED TO THE CONTRACTING OFFICER ARE ATTACHED TO THIS REPORT.

(i) NAME OF INVENTOR	(ii) TITLE OF INVENTION	(iii) PATENT APPLICATION SERIAL NUMBER AND CONTRACTOR'S DOCKET NO.	(iv) CONTRACTOR HAS FILED OR WILL FILE U.S. PATENT APPLICATION		(v) CONFIRMATORY LICENSE OR ASSIGNMENT HAS BEEN FORWARDED TO CONTRACTING OFFICER	
			YES	NO	YES	NO

SECTION II - SUBCONTRACTS *(Containing a "Patent Rights" clause)*

5. LISTED BELOW IS INFORMATION REQUIRED BUT NOT PREVIOUSLY REPORTED FOR SUBCONTRACTS. *(If not applicable, write "None".)*

(i) NAME AND ADDRESS OF SUBCONTRACTOR *(Include ZIP Code)*	(ii) SUBCONTRACT NUMBER	(iii) DATE CLAUSE FURNISHED TO CONTRACTING OFFICER	(iv) DATE SUBCONTRACT COMPLETED
NONE			

SECTION III - CERTIFICATE

CONTRACTOR CERTIFIES THAT THIS REPORT OF INVENTIONS AND SUBCONTRACTS, INCLUDING ANY ATTACHMENTS, IS CORRECT TO THE BEST OF THE CONTRACTOR'S KNOWLEDGE AND BELIEF.

DATE	NAME AND TITLE OF AUTHORIZED OFFICIAL *(Print or Type)*	SIGNATURE
7-7-81	Dr. Daniel R. White, Research Associate Professor	Daniel R. White

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